ACCURACY IN HANDWRITING, AS RELATED TO SCHOOL INTELLIGENCE AND SEX.[1]

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If Preyer is at all right in saying that "the connection between physical and psychical processes reveals itself more plainly in handwriting than in any other voluntary movement" (18:1), a search for correlations in this direction should be profitable. Preyer's own attempt, along with Crepieux-Jamin's (6) and Meyer's (17), to establish graphology on a scientific basis constitutes such a search for correlations on a very ambitious scale. The more restricted investigations by the alienists (7; 11; 17), with the Goldscheider-Kraepelin *Schriftwage*, may also be viewed as a search for the correlates of handwriting, especially the handwriting of the insane. These two fields, the characterological and the pathological, have so far been cultivated to the comparative neglect of the more normal and commonplace aspects of handwriting.

The present study concerns itself with ordinary school penmanship, considered as a motor function. There are peculiar reasons why the handwriting of a large number of school children should be studied from this standpoint. Writing is a very delicate, complicated activity, requiring a high degree of co-ordination and years of almost daily practice before it becomes an established acquisition. Few movements to which the hand of the ordinary child is trained, are more difficult, and in no other example of "manual training" are the degrees of efficiency so conveniently recorded. Furthermore, in the case of no other school activity is there such a conspiracy of influences to secure uniformly excellent results. Constant pressure from the teacher, usually supplemented by praise or blame from the parent, and a mathematically accurate model are for eight years not allowed to lapse, so that here conditions are most favorable for the production of absolute uni-

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formity. The very apparent and tangible differences which appear in spite of these conditions challenge consideration.

The present study limits itself to the differences in the accuracy of penmanship, that is, the differences in the amount of deviation from a perfect copy. The principal material was collected with the assistance of one hundred and five teachers, from the public schools of Worcester, Mass. Each teacher submitted four sets of representative specimens written by the pupils of her grade, as follows:

Group I. Specimens from the three *Best writers* in the grade.

Group II. Specimens from the three *Worst writers* in the grade.

Group III. Specimens from the three pupils of highest mental ability as represented by school standings.

Group IV. Specimens from the three pupils of lowest mental ability as represented by school standings.

To each specimen was attached a slip giving desired data about the pupil, as indicated below:

(1.) *School Intelligence* (as shown by standings): *Very Good, Good, Fair, Poor, Very Poor.*

(2.) *General Intelligence* (irrespective of standings): *Bright, Average, Dull.*

(3.) *Motor Ability* (a careful judgment of the pupil's muscular dexterity, as shown in Drawing, Sewing, Manual Training and general aptness in using fingers, hands and arms): *Clever, Average, Clumsy.*

(4.) *Facility in Writing: Ease, Moderate Ease, Effort.*

The grades represented in the returns are from I to IX inclusive, with a total enrollment of 4,361 pupils. The average number of specimens for each grade is 140; the number for each *Group* is 315, making the total number of specimens classified and tabulated below 1,260.

	Sex		School Intelligence					General Intelligence			Motor Ability			Facility in Writing		
	Boys	Girls	Very Good	Good	Fair	Poor	Very Poor	Bright	Average	Dull	Clever	Average	Clumsy	Ease	Mod. Ease	Effort
Group I	122	193	86	105	82	30	12	122	168	25	124	174	13	187	115	10
Group II	238	77	26	54	92	88	55	60	160	95	18	124	152	52	103	148
Group III	147	168	236	64	5			269	46		159	146	17	171	111	26
Group IV	174	141			22	123	170	11	97	204	23	149	137	56	141	104

The figures show a surprisingly decided tendency for accuracy in children's writing to vary directly with school intelligence. It should also be mentioned, since the above table gives only the sum totals, that the tendency is a constant one, and presents itself with but slight fluctuations in every grade from the first up. In *Group I*, which contains the *Best writers*, there are 191 *Good* and *Very Good* pupils. Out of a total of 315 in this group there are only 25 (7.8%) who are ranked as *Dull* by their teachers. In *Group II*, which contains the *Worst writers*, the corresponding tendency is just as constant. There are 143 *Poor* and *Very Poor* pupils against 80 *Good* and *Very Good*. The number of *Bright* pupils is 60 (19%). The tendency toward a correlation is corroborated by the manner of distribution of those pupils who fall into more than one group. Out of a total of 1,260, the number of *Best pupils* who are at the same time the *Worst writers* is only 6; and the number of *Poorest pupils* who are at the same time the *Best writers* is only 7. On the other hand there are 66 *Best pupils* who are also the *Best writers* and 70 *Poorest pupils* who are also the *Worst writers*. The general tendency was again verified when the 730 specimens in *Groups III* and *IV* were divided into two equal sets of best-written and worst-written specimens; 207 pupils in *Group III* wrote best; 207 pupils in *Group IV* wrote worst. These same 730 specimens were afterwards taken and subjected to a rigorous sifting process, by means of which the more neutral specimens were discarded and two extreme classes of the most and least accurate writing were formed. Of 180 *Very best* specimens, 125 were written by the *Best pupils*, a direct correspondence of 70%. Of the 134 *Very worst* specimens 103 were written by the *Poorest pupils*, a correspondence of 77%.

As a check and sidelight on these results a collection of specimens from the six grades of the School for the Feeble-Minded at Waverley, Mass., was examined. These specimens, 72 in number, were tabulated and classified on a basis corresponding to that used for normal children. The results are in harmony with those already noticed. Out of 18 *Best writers* not one was reported as *Very Poor* (in school intelligence); while out of 18 *Worst writers*, only one was reported as *Very Good*. The number of pupils falling in both *Groups I* and *III* was 4; the number falling in both *Groups II* and *IV* was 7. The division of the specimens in *Groups III* and *IV* into 2 equal sets of best and worst-written, showed that 13 of the 18 *Best* specimens were by *Best pupils*, and 13 of the 18 *Worst* specimens were by *Poorest pupils*.

Before commenting on the nature and validity of the correlation suggested by these results it is necessary to take into

account another factor, which will be seen to have considerable influence on the accuracy of writing; namely, that of sex. The sex differences in writing have already been investigated, notably in the experimental studies by Gross (11: 450) and Diehl (7:1) and in Binet's interesting paper, "*La graphologie et ses révélations sur le sexe, l'âge et l'intelligence.*" Binet believes the existence of sex characteristics in writing "to be demonstrated in a most satisfactory manner" (4:208). These studies, however, are concerned with the handwriting of adults and offer nothing that has an application here.[1]

A few figures will bring out the extent of the sex difference in accuracy of writing. *Group I* contains 193 girls (61%); *Group II* contains 77 (24.6%); *Groups III* and *IV* respectively contain 168 and 141 girls. Of 180 *Very Best* specimens selected from *Groups III* and *IV*, 116 (64.4%) were written by girls; while of 134 *Very Worst* specimens from these two groups, 94 (70%) were written by boys. Again, of 63 pupils falling in both *Groups I* and *III*, 43 (68%) were girls; and of 70 falling in both *Groups II* and *IV*, 52 (74%) were boys. In the high school the differences are most marked. Taking 257 specimens of vertical writing and dividing them according to the uniformity and symmetry of the script into 4 classes, it was found that the most copy-book-like class contained 11 boys' and 43 girls' specimens; and the least copy-book-like class 31 boys' and 7 girls' specimens; that is, the percentage of boys respectively in the most and least calligraphic classes was 20.4% and 82.6%. Again, taking 1,011 papers representing the enrollment of two high schools (445 boys and 566 girls) and discarding 471 border line specimens, we find that of 299 best specimens, 229 or 76.6% are by girls and of 241 worst specimens, 193 or 80% are by boys.

It is evident that we have a sex factor to reckon with here.

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[1] The sex characteristics, whatever they may be, seem to be discoverable to a certain extent below the adult age. The writer made a careful selection of 50 specimens written by high school pupils, with a view of testing the prominence of the difference between boys' and girls' writing; 28 of the specimens were representative, 22 "difficult." Sixteen persons, teachers and students, submitted each to two tests on the set of papers. This made a total of 1,600 judgments; there were only 98 cases of contradiction and 37 cases of no decision. The number of errors was 599 or 37.4%. (The error by mere chance would have been 50%.) 482 or 80.5% of these errors were on the difficult specimens. The average time devoted to each paper on the first test was 12 seconds. Many of the reasons for the judgments, given after introspection, were laden with graphological connotations; but others rested on empirical data such as "I have never in all my experience seen a boy make a *G* that way," etc. The amount and character of the irregularities in the writing were often mentioned in the decision.

It would be difficult to think of any other school activity in which the influence of this factor comes out so strikingly. The usual tests of motor ability, sensory discrimination, etc., reveal only slight differences between boys and girls as a class. Speaking of men and women, Havelock Ellis says, "There are nearly always differences — but these differences are complex and manifold; they do not always agree; they never show any general piling up of the advantages upon the side of one sex or the other." (9.) In the present case, however, there seems to be distinctly such a piling up in favor of one sex.

With the aid of a detailed analysis of the writing process it may be possible to understand the meaning of this sex difference, and also the influence of the other factor of school intelligence. From the start it must be remembered that we are dealing with handwriting during its formative period, when the movements have not yet become fully automatic, and the accompanying conscious processes are different from those which exist with adults. According to Judd (13:243), "Writing, which is essentially a co-ordinated movement, has to be developed trial after trial, with consciousness directed not upon the movement itself, but on the visual images which appear as the results of the movement." "There is no conscious selection of the hand movement," but rather, "it gradually becomes incorporated without any conscious purpose or clear recognition into the total automatic form of movement." "These facts," he says, "make it difficult to attribute to the sensations of movement any important part in the building up of the writing habit or in the maintenance of correct forms of movement, after the habit has been developed. The various factors have been gradually added to each other by a process of organic fusion, not controlled by consciousness. These separate factors are each the result of many trials in which the guiding motives have been, first, the reproduction of visual forms, and second, the avoidance of difficult, cramped positions of the hand." This statement should be taken in connection with Judd's other statement, that the special character of the writing movement is "determined in the main by the influences that are brought into play during the years of practice, which are generally devoted to the acquisition of this art." Such an explanation of the facts reduces this motor function very largely to a mental rather than a physical basis, and makes more probable its correlation with some other function of a psychical order. To quote Judd again, "The individual variations in writing are due to the way in which the visual factors and the factors of movement have been interrelated. If one insists on the constant and clear recognition of the visual

pattern he may ultimately conform the movements by a large amount of practice to his pattern." Throughout his whole analysis, Judd emphasizes the importance of these conscious factors. Success in penmanship, or accuracy in the writing movement, is made to depend upon the capacity and willingness to exercise visual control. The results of Scripture, Smith and Brown's study "On the Education of Muscular Control and Power," point in the same direction. From the outcome of 2,000 experiments they felt justified in the conclusions that "steadiness of movement can be increased by practice," and "this training seems to be of a psychical rather than of a physical order and to be principally in steadiness of attention." (19:114.) Similarly, Hall says, "Exactness of movement is one of the chief products of skill and practice, and is probably more indicative of mental development . . . ." (12:144.) Baldwin holds that "The most adequate theory of the mechanism of (motor) control makes it a function of attention." (2:115.)

However dependent accuracy of movement may be on psychical factors, no one would be disposed to argue that handwriting in any way stands for a high order of intelligence. This is shown by the fact that in cases of insanity where nearly all the mental activities have deteriorated, the writing response is sometimes the only coherent response that can be called forth. The specimens of the handwriting from imbeciles are, likewise, often indistinguishable from those of normal children, in the general appearance and finer co-ordinations of the script. Still it would be wrong to conclude that handwriting is possible with even a very low degree of intelligence. Only imbeciles of high grade can ever hope to acquire the art, and Barr classes it as being more difficult than the use of the hammer and chisel. (3:163.) The slow and labored manner in which even high grade imbecile pupils do their writing must be taken into account, as also their great dependence upon a copy to which they can refer. They have considerable difficulties, for example, with complicated letters like *f*. The learning process makes a demand upon their consciousness, so that as one teacher told me, the appearance of writing in the lower grades is a hopeful indication of dawning intelligence. This teacher has also observed that when the imbecile "child first writes, his penmanship is at its best. When the mind is occupied with the expression of an idea, the writing frequently becomes careless and inferior." But when the mind is not so occupied feeble-minded children take a strange delight in the act of writing, which goes to show that its demands upon the attention are not onerous. They beg to be allowed to write for

"busy work," and are content to copy from their readers by the hour.

Accuracy in writing, then, indicates a kind of intelligence, rather than a grade of intelligence. From the foregoing analysis of the writing movement we saw that the accompanying consciousness was a visual consciousness. In fact, the chief purpose of the writing lesson and the copy-book is to stimulate this visual control. The learning process is a "visual consciousness of the end;" and the relative accuracy of the boys' and girls' writing movements will depend upon their relative willingness and capacity to maintain such a visual consciousness. The decided majority of teachers report that the girls take to writing more readily than do the boys. The number of girls reported as being painstaking in writing is almost twice the number of boys. The number of boys reported as careless in writing is over four times the number of girls. The number of boys reported as disliking writing is over six times the number of girls.

There is evidently a general difference in mental attitude which reveals itself in the accuracy of the writing. Miss Thompson in her extensive study of the mental traits of sex found among women, "a greater taste for working with the hands." "The greater prominence of the visual consciousness among women," she also says, "is especially marked." (21:166.) This is precisely the consciousness which affects accuracy of writing. Jastrow also found among the feminine traits revealed by his study of association, "an attention to the immediate surroundings, to the finished product, to the ornamental, the individual, the concrete." (10:190.) The greater teachability and diligence of the female sex are often mentioned. Riccardi found upon the examination of several hundred school children of Modena and Bologna, that girls have a greater fondness for manual work. (10:202.) That is to say, girls are likely to have a greater interest in writing; and interest and attention are but two aspects of the same function. In the conflict between the visual consciousness and the kinæsthetic and other sensations, the girls attend more to the visual standards and hence are better writers. A comparison of many examples of the most rapid writing in high school boys and girls, shows greater abandon and less embarassment by visual guides in the former. The boys in general, having a milder interest in form and a more vigorous one in content, are much more inclined to allow the visual patterns to lapse, in favor of kinæsthetic sensational control, to the detriment of their writing. By this reasoning the sex differences in the accuracy of penmanship are attributable to differences in mental attitude.

But to reduce the whole writing activity to mental elements

would be to ignore some of the facts. Even Judd mentions the existence of "inherited nervous structures," which furnish a general basis for the writing habit. To what extent does this factor of physical structure influence accuracy of writing? The individual differences in size and proportions of the hand, have been shown to have but slight, if any, importance even in determining the general conformation of the script, and probably have little effect upon accuracy of digital or manual movement. There are general differences between men and women in the length of the hand, index finger and thumb; but these likewise are too small to explain the sex differences in the accuracy of children's writing. It is difficult, in any case, to determine when and to what extent clumsiness has *per se* a physical basis. Some of our data, however, are suggestive on this point. The teachers, it will be recalled, were asked in every case to give a careful judgment on the muscular dexterity of each pupil, designating whether *Clever*, *Average*, or *Clumsy*. They were also asked to state whether the pupil wrote with *Ease*, with only *Moderate Ease*, or with *Effort*. The returns on these points are very uniform. Handwriting seems, in all the grades, to be a fairly good index of the general muscular dexterity of the pupils as judged by the teachers. Only 13 out of 315 *Best writers* were otherwise *clumsy;* and only 18 out of 315 *Worst writers* were otherwise *clever*. (It is worth noticing incidentally that there is a marked tendency for this muscular dexterity to vary with mental ability. Of the 315 pupils in *Group III* only 17 were reported as *clumsy*, and of 315 in *Group IV* only 23 were reported muscularly *clever*.) Of 315 *Best writers* only 10 write with *effort;* of 315 *Worst writers* only 52 write with *ease*. These reports, although they represent no more than the observations and estimates of the teachers, are too uniform to be disregarded.[1] It would be begging the question to say that they indicate the existence of purely physical differences in nervous organization, but they point in that direction. Another fact which points in the same direction, is that not infrequently pupils reported as painstaking in their writing are nevertheless inaccurate writers. Writing does not come with equal ease to all. I have inquired into a number of such cases and have found what one would prefer to call physical explanations. Sometimes the poor writing has been described by teachers who have had other members of the fam-

[1] It is obvious, of course, that such a uniformity was to be expected if the teachers in their judgments as to dexterity in general were unconsciously determined by skill in penmanship. How far this was the case it is impossible to say, though other forms of muscular activity were specially enumerated in the request for information.

ily under observation, as a family trait, which would naturally be interpreted as an inherited physical trait.

The results of the investigation of Dr. Macmillan, of the Child Study Department, of the Chicago public school system, are *apropos*. After studying the spontaneous writing of many children, he came to the conclusion that "the slope in writing is more a matter of the child's anatomical structure and muscular co-ordination than the individual caprice on the child's part or instruction on the part of the school." (15.)

A close examination of our data reveals another group of facts which are suggestive along this line. Up to the fifth grade, the number of boys and girls in *Group I* is almost equally distributed for each grade, the total number of boys being 70 and the total number of girls being 71,—practically no sex difference at all in the accuracy of the writing. But at the fifth grade the figures take a sudden shift which is stable for the remaining grades, the number of girls who write accurately being twice the number of boys. This shift is at the age of ten years, when the mental traits distinguishing the boys from the girls begin to be more pronounced; but this is also the age when the physical precocity of the girls over the boys takes its start, and the fact that this advantage continues up to the high school age, while the writing habit is being established may not be without important influence. At any rate the sex differences in writing become more marked after the fifth grade.

The tendency toward inaccurate writing among the boys, however, is as pronounced in the first grade, as in all the succeeding grades, which raises the question whether this tendency is not in part constitutional, structural. Sikorski, the authority on speech defects, found after examining some 10,000 pupils that the proportion of left hand writers is almost twice as great for boys as for girls. He also found by comparing the copy books of boys and girls, that ataxic handwriting was from seven to eight times more prevalent with the former. (20 : 208.) He correlates these facts with the well known truth that boys are about three times more susceptible to speech defects than girls. This is a neurological susceptibility, that may extend over to the writing centre which stands in close relationship to that of speech. It is not improbable that the inveterate tendency of many boys toward inco-ordinated writing has a physical background.

Havelock Ellis found stammering and other speech and voice defects and nervous derangements in general common among his British men of genius. He classes bad handwriting along with these defects and approvingly quotes Goodhart, who calls illegibility a disease. Says Ellis, "Illegible handwriting is mentioned in nine cases which certainly need to be increased. . . .

A tendency to scrawly or illegible handwriting has been frequently noted among men of genius of many countries, and is by no means due to too much writing, for it is often traceable at an early age." (8:200.)

All these facts point to possible physical differences, the full importance of which it is impossible to evaluate when it comes to correlating handwriting with other functions. So far as the results of this study go, they emphasize the prepotence of the psychical factors. The influence of differences in intelligence has been noticed, and making some allowance for differences in nervous organization, the influence of the sex factor may be safely attributed to differences in mental attitude. The fact that other studies have shown such slight differences between boys and girls in motor ability tests, and then in favor of the boys (1:193; 5:123), gives weight to this view.

In the end, it is difficult to decide between the primacy of the two factors of sex and school intelligence. In the writing of the high school period the former factor comes out strongly; but an examination of the standings of over 500 pupils shows the latter factor, while present, to be much weaker than in the grades. On the other hand, in the School for the Feeble-Minded where the sexes are segregated, the differences in school intelligence were alone important enough to influence the results. Again, when we take, for example, the minority of 122 boys' specimens in *Group I* and classify them on the basis of the mental ability of the writers, there is a decisive piling up of the specimens in the best scholarship class. Likewise, we have already observed, that below the fifth grade, the distribution of best specimens was almost equal between boys and girls. This fact, however, did not prevent in these grades a marked tendency of the best writing to accompany the higher school intelligence. Individual cases which do not fall under the general rule, and, indeed, often strikingly contradict it, are not wanting either in the high school or the grades. *Accuracy in writing stands for a certain kind of intelligence, and what our results mean is that for a large number of cases, this particular kind of intelligence is more prevalent in girls and in pupils above the average in school standing.*

One other result of the study remains to be mentioned. It has already been observed that painstaking qualities did not always produce accurate writing. In view of the common assertions about manual training, it is interesting to inquire further whether painstaking or careless qualities in a motor function like writing bespeak the same qualities in other school work. Sixty-five pupils (45 boys; 20 girls) were mentioned as careless in writing but painstaking otherwise; 42 pupils were reported as painstaking in writing and careless otherwise.

But these 107 cases, in the minds of the teachers reporting them and in the light of additional figures, are exceptional. In the 917 remaining reports, painstaking or careless qualities in writing bespoke similar qualities in general school work. That is, in 1,022 cases reported as clear instances, there is on this point a direct correlation of 90%. This correlation is so fundamental that it shows apparently no dependence on the three factors considered in this study: school intelligence, sex differences, and accuracy in writing.

SUMMARY.

1. For a large number of cases, accuracy in the handwriting of pupils of elementary grade tends to vary directly with school intelligence.

2. From the fifth grade up through the high school, girls as a class write more accurately than boys.

3. Boys as a class show a greater tendency toward incoordinated writing as early as the first grade and up through the high school.

4. The sex differences in writing become marked about the age of ten, and are largely attributable to the mental factors.

5. If handwriting is an index, painstaking or careless qualities in a motor function bespeak, in pupils of elementary grade, the same qualities in general school work.

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